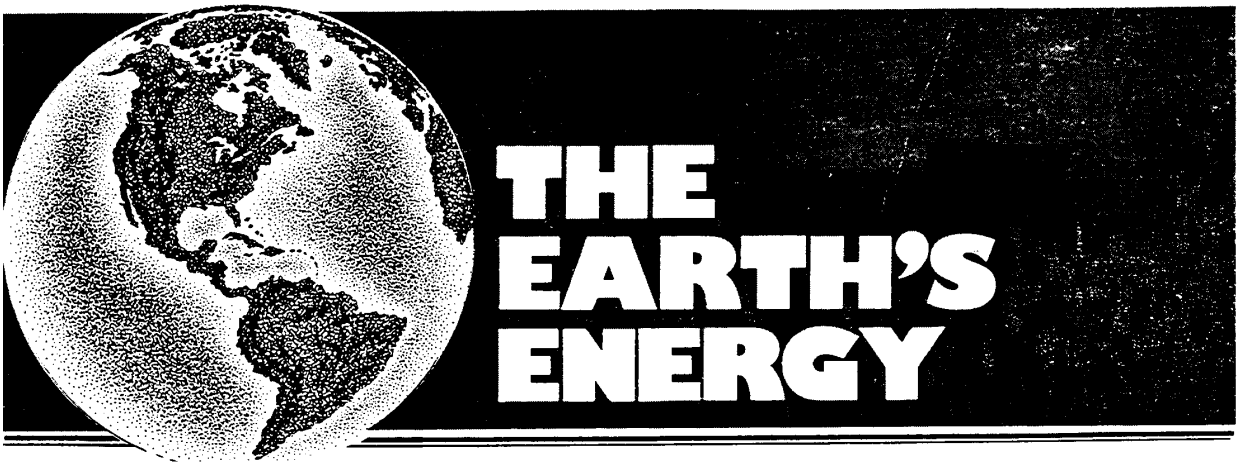


What Is Geothermal Energy?

Geothermal energy is heat which naturally exists beneath the earth's surface. Man has long been fascinated with this phenomenon. Naturally heated water has been used in therapeutic spas, and the splendors of hot springs and geysers have made areas like the Yellowstone National Park popular vacation spots.

This naturally occurring heat can also be developed to provide heat for our homes, businesses, and industries. In many areas of the world, this is common.

Such intensive geothermal applications require the availability of water of a fairly high temperature.

Unfortunately, such temperatures occur only in the relatively deep bedrock formations underlying North Dakota. While such formations yield significantly higher temperature water supplies, the expenses of drilling to and pumping from those depths and the frequently lower water quality are significant barriers to developing those resources. Low to moderate temperature water resources are much more common in our region, and they represent the geothermal resource that has been most widely utilized in this region.■

How Is Geothermal Heat Used In North Dakota?

The most common geothermal applications in North Dakota utilize relatively low ground temperatures as a constant temperature source for a heat pump, which provides space heating.

In North Dakota, there are currently over a hundred homes which are heated with groundwater heat pumps, and one school heats with such a system.

A groundwater heat pump system takes groundwater from a well and runs it through a heat pump which extracts heat from the water. The water is then returned to the ground by reinjection well.

There is also currently a great deal of interest in closed-loop ground source heat pumps. These systems circulate water or another fluid through the ground in a closed loop system. They may be either vertical loops installed in drilled holes or horizontal loops buried by trenching. The loops are typically constructed of high-density polyethylene or polybutylene pipe which are fusion welded.

While there is a great deal of interest in the closed-loop systems, more groundwater heating-systems have been installed in North Dakota to date.

Groundwater and ground source heat pumps, if reversible, can also provide cooling.■

What Is A Heat Pump?

A heat pump uses a low-temperature liquid refrigerant in a closed system. It evaporates, drawing heat away from its surroundings. The vapor is then run through a compressor which extracts the heat.

In the case of the groundwater heat pump, the groundwater is the source from which the heat is removed.

A heat pump with which we are all familiar is our refrigerator.

The refrigerator uses a heat pump to draw heat out of the refrigerator's interior, even if it may already seem cool inside.■

Why Use Groundwater Or Ground Coupling — Why Not Just Use Outside Air?

The groundwater or fluids heated by ground temperature are ideal heat sources for heat pumps for a couple of reasons. First, water has the highest specific gravity of any common substance. This means that it holds more heat than other material weighing the same.

Secondly, ground temperatures in North Dakota are fairly consistent. Air temperatures vary greatly, and air temperatures are usually too low to economically use as a heat source in the winter months when heat is needed the most. When a heat pump operates in extreme temperatures, its efficiency, or coefficient of performance (COP), decreases tremendously.

The COP is a ratio which describes the amount of heat energy extracted by the heat pump for each unit of heat used to run it. While a groundwater heat pump may have a seasonal heating COP of 2.2, an air-to-air heat pump will only have a seasonal heating COP of 1.4. In extremely cold months, it may have a COP of 1 or less.

A ground-coupled heat pump will offer similar performance to one which utilized groundwater.■

How Does This Affect Home Heating Economics?

The University of North Dakota's Engineering Experiment Station evaluated the relative heating and cooling costs for various fuels. Their calculations were based upon a home with a 50,000 BTU heat loss at a 9000 degree day location.

By applying current energy prices to their computations, the following estimates of annual heating costs were calculated. They show the relative heating costs of various fuels:

HEAT SOURCE	COST	ESTIMATED ANNUAL HEATING COSTS	SEASONAL EFFICIENCY OR C.O.P
Fuel Oil	($1.00/gal)	$1173	.74
Natural Gas	($5.00/mcf)	$407	.84
Natural Gas	($6.00/mcf)	$488	.84
Natural Gas	($5.00/mcf)	$352	.97
Natural Gas	($6.00/mcf)	$423	.97
Propane	($.75/gal)	$667	.84
Electrical Resistance	($.06/kwh)	$1202	1.0
Air-to-air heat pump	($.06/kwh)	$859	1.4
Groundwater heat pump	($.06/kwh)	$546	2.2

As you can see, groundwater and ground coupled heat pumps are competitive with a number of other fuel types in areas where natural gas is not available at low prices.

Groundwater heat pump systems are, however, rather expensive. Therefore, another type of heating system, which initially costs less, may be the most economical.

The UND Engineering Experiment Station estimated that a groundwater heat pump system could cost as much as $5000 plus a cost of approximately $1000 for installing ductwork, if it is not already present in the home. Of the $5000, $3100 goes to the heat pump itself, $1600 for the reinjection well and the extraction well if one does not already exist, and $300 for plumbing work. The cost of the well includes the approximate costs of drilling two forty-foot wells with four inch casings and the cost of a proper pump.

Estimates of closed-loop ground coupled heat pump systems are not available and will vary greatly depending on the costs of installing the sized loop required.

This compares to an electric resistance heating system which may cost as little as $500, or a new propane or natural gas furnace of moderate efficiency which may cost about $1650. A modern, high efficiency one may be obtained for about $2500.

The groundwater heat pump system, when looking at heating costs, is shown to be cost effective when compared to some fuel alternatives, and not competitive with others.

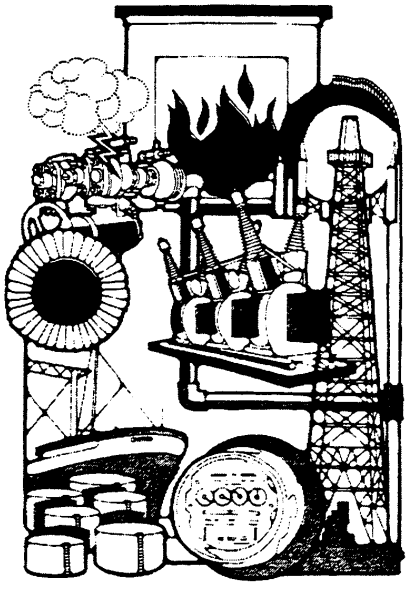
The groundwater heat pump has an additional advantage, which other heating systems do not have. Its reversible nature gives the system the ability to cool a home as well as heat it.

It draws heat from the house in the same way that it draws heat in during winter. It then dumps the heat into the water which circulates through the system. This central cooling capacity would take the place of an air conditioning system worth at least $1200, and that cost would have to be added onto the costs of competing heating systems if one is to fairly compare system costs.

Unlike other renewable energy applications, a ground coupled heat pump system does not qualify for the federal renewable energy tax credits which are currently in effect (Oct. 1985). The state renewable energy tax credit of 15% (5% a year for three years following installation) does qualify. Anyone interested in these credits should contact the Renewable Energy Program at the Office of Intergovernmental Assistance for current information.■

Alternate Energy Strategies

While a groundwater heat pump heating system may be able to cut your energy bills, it does cost a lot initially. As would be the case with any other product you were investing in on the basis of the return which that investment will provide you, you should compare it to alternate investment strategies to make sure you are getting the best possible return for your money.



You should especially look at alternate energy conservation investments. It may be that similar savings could be achieved through the installation of insulation, or a more efficient furnace, and these savings may come with a smaller initial investment. This would make the alternate technique preferable, since it would pay for itself much faster.

Most homes have significant conservation potential, so several approaches should be investigated.■

Water Issues

A groundwater heat pump requires a significant volume of water. Depending on the size of the system and the groundwater temperature, the Cooperative Extension Service estimates that a heating system will require a flow of between three to twelve gallons per minute.

No permit is required for wells which appropriate less than 12.5 acre-feet of water, if the water is intended for domestic or livestock purposes. A water use permit is required, however, for multiple-use, municipal, irrigation, commercial, and industrial wells.

Typically, in a groundwater heat pump system, this water is disposed of by returning the water to the aquifer from which it was extracted, although in some cases the water may be used for secondary purposes, discharged to evaporation or seepage ponds, or discharged directly. All water disposal wells must meet standards set by the North Dakota Department of Health and must be registered with the Department. Since the water which is returned is a few degrees colder than it was when taken out of the ground, the well and the reinjection well should be spaced far enough apart to prevent a loop from forming. Typically, the two wells are spaced about 125 feet apart, depending on the exact installation.■

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